DSN Tracking System: Operation With the Mutual Stations

W. D. Chaney and H. E. Nance
DSN Engineering and Operations Section

Two types of 26-m tracking stations are available to the Deep Space Network (DSN) for spacecraft tracking. Pioneer F will be supported primarily by the Mutual stations. This article describes in some detail the various functions performed by the Mutual station tracking system and compares its equipments and functions with those of the standard DSN tracking station. The operational capabilities and interfaces between the modules within the station are presented in the logical sequence, with the final output interfacing with the Ground Communications Facility and the Space Flight Operations Facility.

I. Introduction

The primary function of the DSN Tracking System is to provide precision radio-metric data to be used for the determination of the orbit of a spacecraft in deep space. Radio-metric data includes angle data, range data, and doppler data with associated status information, time, frequencies, data condition, and calibration data generated by the tracking station. The tracking system also provides tracking predictions (observables) for use in acquiring the spacecraft radio-frequency signal and for system data validation.

Two types of 26-m stations are available within the DSN for the acquisition of radio-metric data: the standard DSN station and the Mutual station (combined DSN and STDN equipment). The Mutual stations are DSSs 11, 42, and 61 and are committed to the support of the *Pioneer F* Mission and *Apollo* Missions. This article discusses the Mutual stations only.

II. Mutual Station Configuration

The tracking system at the Mutual stations is shown schematically in Fig. 1. As information, this configuration differs from the standard 26-m DSN station in that the STDN TDP (tracking data processor) replaces the DSN TDH (tracking and data handling subsystem) and the STDN APP (antenna position programmer) is added.

III. Radio-Metric Data

The TDP (tracking data processor), in conjunction with the APS (antenna-pointing subsystem), provides the Mutual station with the capability of transmitting radio-metric data to the SFOF via high-speed data lines (HSDL) or teletype circuits.

The high-speed data (HSD) is sent in a 1200-bit block, of which 1044 bits are available for data, with 156 bits being used for sync code, routing information, accounting

data, time tagging, and error detection. The sample rate of the data acquired is variable from 1/s to 1/60 s and a HSD block is transmitted when five samples are accumulated in the block. The rate of transmission of the HSDL is 4800 bits/s, requiring only one fourth of a second for transmission of the radio-metric data block. The rate of HSD block transmission is dependent on the sample rate of the data and varies from 1/5 s for 1-s data to 1/5 min for 60-s data.

The teletype data is sent directly from the TDP via the normal GCF teletype circuits. The sample rate of the data is likewise variable, being from 1/6 s to 1/10 min as well as a manual rate. There is only one format from the Mutual stations for the teletype data in contrast to the multiple formats available from the standard DSN stations.

A capability is provided for non-real time recovery of the radio-metric data. The HSD recovery is from the DSS original data record (ODR) by retransmission of any requested block or combination of blocks by block serial/sequence number or by the time of original transmission as indicated in the GCF header. The teletype recovery is from paper tape that is punched during data acquisition and requested recovery is by time only.

IV. Equipment Operation and Interfaces

The TDP samples and formats Greenwich Mean Time (GMT), doppler, range, angles, and partial status and outputs the sampled data to the APS for transmission via HSD or directly out to the GCF via teletype.

The APS also receives predictions generated in the SFOF and transmitted via HSDL or TTY to the station. The APS then interpolates these predictions to 1/s, and provides interpolated angles to the APP (antenna position programmer). A paper tape, to serve as a backup drive for the APP is punched on the APS computer high-speed tape punch at the same time. However, this tape only contains time-ordered antenna pointing information for every tenth point generated by the APS, or 1/10 sec. In addition, DSIF tracking system partial status information is transmitted to the DIS (digital instrumentation subsystem) by the APS.

The APP receives the 1/s predicted angular positions from the APS and further interpolates these angles to 50/s; it compares the 50/s predictions with the antenna angle readout and generates an error signal to the antenna servo subsystem. The antenna servo subsystem then drives the antenna to null this error signal, insuring smooth, accurate tracking of the spacecraft.

The DIS receives partial status and error alarms from the TDP for DSS operational control and DSN monitor functions. The DIS also receives predicts via HSDL from the SFOF and outputs page prints of the predicts for station spacecraft acquisition operations.

V. SFOF Operation

The SFOF has many internal operations in connection with the radio-metric data received from the Mutual station; however, only two prime interfaces will be discussed.

The SFOF tracking data input processor, TTY (TYDIP) provides data format identification, decommutation, data conversion, and reformatting. Alarms are generated for bad formats and data out of limits.

The SFOF high-speed data input processor (HYDIP) receives radio-metric data via HSDL and performs block error detection, data decommutation, conversion, and reformatting. Alarms are generated for HSD block transmission errors and data out of limits.

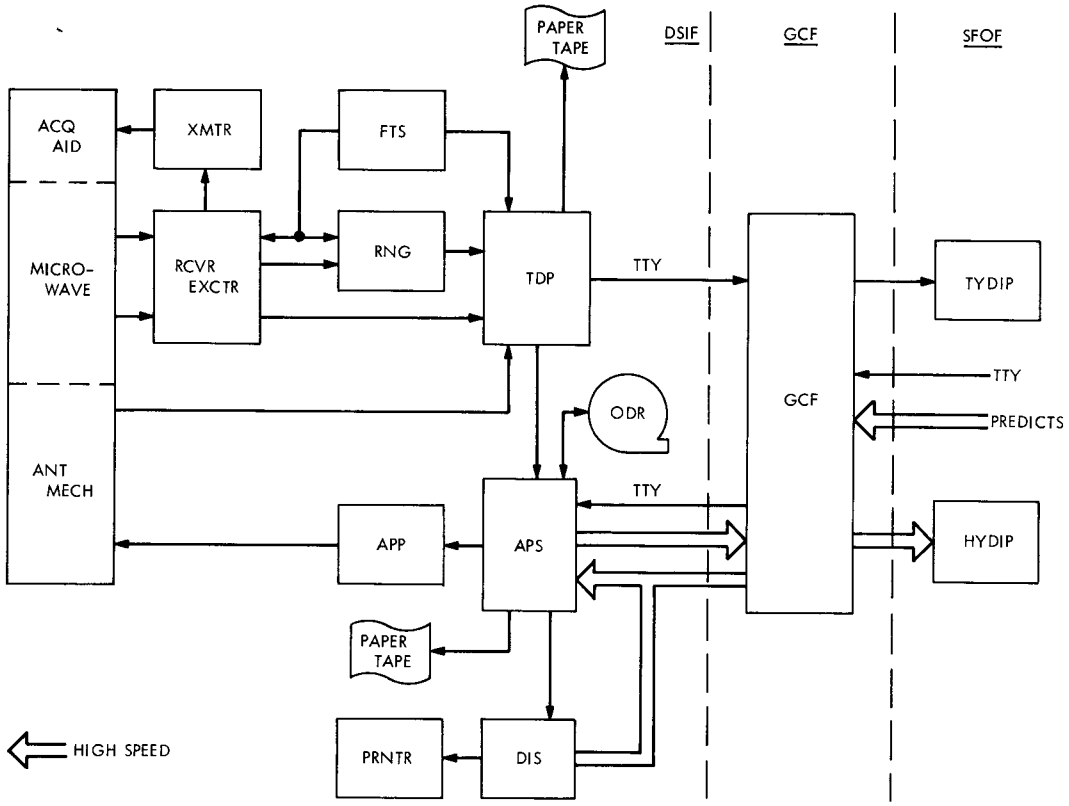

Fig. 1. Mutual station tracking system